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Weather Integration on the Flight Deck –

A Concept of Use Based on Operational Need

Presentation for the
6th iCNS Conference and Workshop
Baltimore, Maryland

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May 2, 2006

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Issue

- **Weather disrupts the system!**
- **For all classes of pilots, flight diversions, compromises in safety, and sometimes fatalities occur due to**
  - **Incorrect mix of weather information of decision-making value available in the cockpit**
  - **Non-effective display/presentation of weather information**
  - **Pilot error**

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Problem/Challenges

- **Validated weather information needs to the flight deck are largely unknown**
- **What kinds of weather information are important for flight deck decision making, why is it important, and how should it be presented?**
  - **General guidance towards integrating weather onto displays is not well defined**
  - **What is the balance between valuable information with that which will be used?**
  - **Integration issues: Human-Over-the-Loop? Machine-Machine Integration?**
  - **Weather for Situational Awareness?**
- **Various studies have examined the use of currently available weather products**
  - **Unclear as to how pilots may use weather integrated displays under deteriorating conditions**
  - **Important because GA VFR flight into IMC leads to a disproportionate percentage of fatalities**
- ***Need applicability beyond VFR flight!***

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Previous Studies – Some Surprises

- **No Surprise:**
  - **Value of NEXRAD Looping Products and National Convective Forecast Product less than surmised**
  - **Willingness to continue flight after half-way point – inconsistent**
  - **Attention tunneling**
  - **Separate moving map weather display provided little additional decision making value**

- **Surprise:**
  - **Improved resolution of weather products (NEXRAD) increased attention tunneling!**
  - **“More detailed” graphics equated to less looking out the window!**
  - **Does this mean more “valuable” weather information also leads to increased attention tunneling and less looking out the window?**

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Where Do We Go From Here?

- **What weather information are we going to integrate?**
  - **Tough to answer without weather info need**
  - **Integrating the wrong information (problems!)**
- **How do we integrate and/or display?**
  - **Tough to answer without knowing the above?**
- **What weather information will be used effectively?**
  - **Do we need to re-examine weather concept of use?**
  - **Maybe if we address this, we can tackle the what and how integration questions**

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There is a need to determine the balance between what kinds of weather information are needed, and when, for situational awareness and decision making VS. any and all natural human proclivities that will ultimately determine how they will use that information

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A "New" Concept of Weather Use

- **Based on:**
  - **Information need, integration and use reduced to only those times when pilot is required to make an operational decision or to monitor pre-defined deteriorating conditions important for situational awareness**
    - **Weather information "pushed" to the cockpit and filtered: Assumes broadcast**
    - **Assumes on-board processing**
    - **Options to avoid 'hazardous' weather incorporated**
    - **All other weather information is made available only by pilot request (if any)**
  - **"Intelligent Decision-Making Tool" Vs. "Weather Product"**

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Concepts

- **Decision Zone**
- **Decision Weather**
- **Trend Weather**
- **Decision Point**

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Decision Zone

- **The 4-dimensional area directly in front of the moving aircraft that is of most interest to the pilot with regard to weather of operational impact to flight**

- **Time horizon and volume of interest based on phase of flight and speed of aircraft**
  - **5 minutes to a maximum of 15 minutes in the future**

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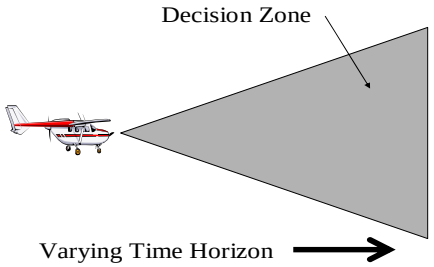
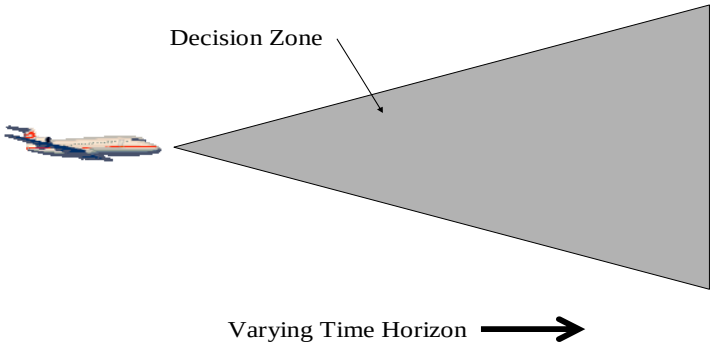
Decision Zone





Volume of the airspace is normalized based on aircraft speed by on-board processing

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Decision Weather

- **Any weather that triggers a change in flight plan**
  - **Decision weather occurs in the Decision Zone and/or at the destination airport**
  - **Varies from aircraft to aircraft, airspace to airspace, pilot to pilot**
  - **Thresholds driven by aircraft performance, airspace or other regulations, pilot experience, personal minimums, etc.**

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Trend Weather

- **Weather that is needed for Situational Awareness**
  - **Weather conditions in the Decision Zone and/or at the destination airport that must be monitored either by the pilot and/or on-board intelligent processing**
  - **May or may not lead to a Decision Point**
  - **On-board processing begins the provision of flight ‘options’ even though no immediate change in flight is required**

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Trend Weather CONT

- **Trend weather is geared specifically to aircraft mission and operational thresholds of interest**
  - **Goes beyond just GA VMC flight**
    - **Ceiling/Visibility important**
    - **Convection**
    - **Turbulence**
    - **Icing**
    - **Wind Shear**
  - **Applicability to IFR flight and other NAS decision makers**
    - **Capacity/Use of Airspace**

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Decision Point

- **Weather conditions in the Decision Zone or destination airport that necessitate an operational decision**
  - **For VMC GA flight this should be where conditions are still better than IMC**
  - **For other classes of users this should be at the pre-determined operational thresholds**
  - **On-board processing provides ‘best’ flight ‘options’ based on conditions just outside the Decision Zone or at alternative destinations**

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Trend Zone/Decision Point

Also can be any operational threshold that triggers a decision

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Integration

- **Machine-to-Machine**
  - **Ground to flight deck**
  - **On-board intelligence**
    - **Continual determination of Decision Zone**
    - **Filtration of broadcast weather for Trend and Decision Weather only**
    - **Determination of flight options**
  - **Intelligent decision aide that incorporates weather as a 'weighing factor' against optimal conditions**
    - **Less focus on a separate or 'layered' display of a weather product/graphic**
    - **More focus on situational awareness and flight options**

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Discussion

- **Weather as a weighing factor greatly reduces the need for pilot or other decision maker interpretation**

- **No separate or overlaid weather graphic: Eliminates color, clutter, orientation and interpretation issues**

- **Situational awareness defined and allows the intelligent aide to monitor and define area of interest**
  - **Pilot attention focus on only that weather which may require flight plan change**
  - **Awareness of options for alternative flight/destination**

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